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PAVING COMPOSITIONS

Related Applications

This application claims priority under 35 U.S.C. §119 from Malaysian patent application serial number PI 20004199, filed September 11, 2000.

Field of the Invention

The present invention generally relates to a paving composition, in particular to stone mastic asphalt compound as a road paving composition.

Background of the Invention

Aggregate-containing asphalt has been employed as a paving composition for roads or the like for many years. The asphalt includes bitumens as a predominant constituent and is conventionally obtained as a solid residue from the distillation of crude petroleum. The asphalt is converted to a fluid state when paving a road. One fluid form is the suspension or emulsion of the asphalt in water. After spreading and compressing the aggregate-containing asphalt, water evaporates and the asphalt hardens into a continuous mass.

Summary of the Invention

The present invention includes new technology that utilizes a specific aggregate gradation and matrix for high stability. Specially formulated fibre mastic asphalt is used to hold the aggregate matrix in place while providing extended durability. The special formulation is able to handle heavy loading from commercial trucks and thus minimize pavement surface distresses. Some of the major applications of this cost effective technology are, for example, at traffic stop signs, exit and access ramps of highways, expressways, water ponding areas on highways, ascending and descending lanes, port areas with heavy container movements and parking lots. The use of the technology of the present invention is expected to reduce the cost of the material by 15 to 20 per cent.

Accordingly, the present invention in one aspect provides a paving composition that has improved resilience and is able to handle heavy loading of commercial vehicles. The present invention in another aspect provides a paving composition that can minimize pavement surface distresses and is economical to produce.

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These and other aspects of the invention are accomplished by:

A paving composition comprising aggregate and asphalt characterized in that:

a) a major proportion of the composition by weight is aggregate; and

b) a minor proportion of the composition by weight is asphalt.

The aggregate comprises particles of a size such that at least 80 percent will be retained on a 2 mm sieve passing 19 or 20 mm sieve sizes, and about 60 to 75 percent will be retained on a 7 mm sieve passing 19 or 20 mm sieve sizes.

The paving composition technology according to the present invention provides an economical means to produce paving composition that are resilient, capable of handling heavy loading of commercial vehicles and providing a cost effective technology.

Brief Description of the Drawings

Other aspects of the present invention and their advantages will be discerned after studying the detailed description in conjunction with the accompanying figures in which:

Figure 1 is a schematic representation of a preferred embodiment of the paving composition according to the present invention. Depicted are: (a) stone skeleton or matrix; (b) mastic; (b1) filler; (b2) quarry dust; (b3) asphalt; (b4) cellulose (oil palm fibre); and (c) stone mastic asphalt comprising stone skeleton filled with mastic.

Figure 2 is a comparison between a magnified view of stone mastic asphalt according to the present invention and a magnified view of a conventional mix for road paving. Depicted are: (a) conventional mix; and (b) stone mastic asphalt (SMA).

Detailed Description of the Invention

The aggregate used in the paving composition according to the present invention may be of a type conventionally employed in the road building industry. It may range from fine particles, such as sand, to relatively coarse, ground particles such as crushed stone, gravel or slag.

As mentioned above, the paving composition according to the invention contains a major proportion by weight of aggregate; as is conventional for road paving compositions.

The paving composition according to the invention is generally used in a method of producing a paving layer, which comprises applying a composition according to the invention to a substrate (such as the surface of a road) and curing the asphalt such that the aggregate in the paving layer is bonded together by cured solid asphalt.

Process

The paving composition of the present invention, stone mastic asphalt (SMA), is formulated with raw and processed materials using new techniques and processes, as shown in Tables 2 and 3. The details of the ingredients, mixing and compaction control processes are described below.

Aggregates

The aggregates for use in SMA should conform to the physical property requirement as shown in Table 4. The aggregates shall be heated up to a temperature of between 150°C and 200°C, prior to mixing with the mastic asphalt. SMA uses aggregates like granite, basalt, quartzite, industrial slag, crushed concrete, crushed bottles, sand and sludge stones from domestic wastes. The types, sizes, shapes, and gradation of the aggregates to be used in SMA shall be as described in Tables 1 and 2. SMA uses specific gradation envelopes for different SMA products like SMA 14, SMA 12.5, SMA 10, SMA7, and SMA5.

Table 1: SMA Aggregate Gradation Envelope

Sieve Sizes	SMA14 % Passing	SMA12.5 % Passing	SMA10 % Passing	SMA7 % Passing	SMA5 % Passing
19.0 mm	100	100			
14.0 mm	80-100		100		
12.5 mm		80-95			
10.0 mm	60-95		80-96	100	100
9.50 mm		71-90			
6.70 mm	44-76		56-86	75-95	
5.00 mm	30-56				65-95
4.75 mm		40-70	46-60		
2.36 mm	19-30	16-30	17-30	42-60	40-50
0.60 mm	10-17	10-20	10-20	10-20	10-20
0.30 mm	6-15	9-13	9-13	9-13	9-13
0.075 mm	4-10	4-10	4-10	4-10	4-10

The selection of the above sieve sizes and individual envelopes was developed after interactive research work at UPM Highway laboratory

Table 2: SMA Aggregate Proportions for SMA14, SMA12.5, SMA10, SMA7, and SMA5

Sieve Sizes	SMA14 % Retained	SMA12.5 % Passing	SMA10 % Passing	SMA7 % Passing	SMA5 % Passing
19.0 mm 14.0 mm 12.5 mm 10.0 mm 9.50 mm 7.0 mm 5.00 mm	60-70% retained on 7.0 mm sieve passing 19 or 20 mm sieve size	55-65% retained on 7.0 mm sieve passing 19 or 20 mm sieve size	50-60% retained on 7.0 mm sieve passing 19 or 20 mm sieve size	45-55% retained on 7.0 mm sieve passing 19 or 20 mm sieve size	40-50% retained on 7.0 mm sieve passing 19 or 20 mm sieve size
4.75 mm 2.36 mm 0.60 mm 0.30 mm 0.075 mm	80% or more retained on 2.36 mm or 2.0 mm passing 19 mm or 20 mm	75% or more retained on 2.36 mm or 2.0 mm passing 19 mm or 20 mm	70% or more retained on 2.35 mm or 2.0 mm passing 19 mm or 20 mm	65% or more retained on 2.36 mm or 2.0 mm passing 19 mm or 20 mm	60% or more retained on 2.36 mm or 2.00 mm passing 19 mm or 20 mm

Table 3: SMA mix Design Parameter

Voids in Total Mix (VTM), percent	3-5
Asphalt Mastic Cement, percent	5.8 minimum
Voids in Mineral Aggregates (VMA)	16 minimum
Stability, kN	7.0 minimum
Flow	2-4 mm
Compaction, number of blows on each side of test specimen	50 for normal use and 75 for heavy duty
Drain-down of mastic asphalt, percent	0.35 max (2 hour reading)
Mastic Asphalt Heating temperature	155 C-175 C
Aggregate Heating temperature	150 C-180 C
SMA compaction temperature	135 C minimum
#40 tire rubber/latex powder, percent	2-10 by weight of 80/100 Asphalt
-#200 rock fillers	4-10 by weight of aggregates

Table 4: Aggregate Physical Properties

No.	Aggregate Tests	Quality Requirement
1	Los Angeles Abrasion	30% max
2	Sodium Sulfate Soundness loss	15% max
3	Aggregate Crushing Value	30% max
4	Absorption	2% max
5	Polished Stone Value	49 minimum
6	Flatness & Elongation	3:1 ratio 25% max 5:1 ratio 10% max
7	Angularity Number	5-10
8	Specific Gravity	2.58 minimum

The above aggregate properties can be confirmed by testing using ASTM, BS.MS or AASHTO standards

Mastic Asphalt

An asphalt with a penetration between 80 and 100 (80/100) shall be stabilized or modified with tire or latex powders of sizes 30 to 50 microns in a proportion of between 2 and 10 percent by weight of asphalt and cellulose fibre pellets that form the asphalt or binder mastic. Rock or slag fillers may be used in place of the above in a proportion of between 4 and 10 percent by weight of aggregates.

The main source of cellulose fibre are from oil palm, coconut, kenaf, rubber-wood and paper pulp, which are used in the formulation of fibre mastic. The cellulose fibres are specially ground and pulped to specific micron sizes that are found to give the best possible performance in terms of stability and drain down of asphalt. The cellulose fibres are mechanically pelletized with light asphalt emulsions or any other suitable materials, for easy packaging, storage and introduction into drum mix or batch mix plants. The proportion of emulsion to coat cellulose fibres is between 10 and 40 percent by weight of fibres.

Mix Design and Control

Both the heated materials are mixed for a duration of between 30 seconds to 3 minutes before the specimen can be compacted. The specimen or mixed SMA compound shall be compacted at a temperature not less than 130°C at 50 blows per side for normal use and 75 blows per side for heavy traffic loading.

SMA Mix Drain-down Analysis

The uncompacted hot samples are tested for their mastic asphalt drainability using stainless steel ¼ inch mesh baskets. The mix shall not drain down more than 0.3% maximum by weight of total mix.

Performance Testing

The compacted samples shall be tested for the following to ensure quality and durability:

Stability:

It measures the strength of the SMA paving compound after placing the specimen in a water bath of 60°C (service temperature of pavements) for about 30 minutes. The samples are expected to display a minimum strength of 7.0 kN with a flow that falls within 2 to 4 mm range. The specimen is also expected to have a design airvoids of between 3 and 5%.

Moisture Induced Test:

Tropical countries like Malaysia receives heavy rainfall that cause pavement damages due to moisture problems. SMA samples are expected to display a Tensile Strength Ratio (TSR) of at least 75%.

Modulus Values:

The resilient modulus of the compacted SMA shall attain a minimum value of 3000 Mpa. The samples shall also display a minimum value of 10,000 load cycles to failure in terms of dynamic impact loading.

While the preferred embodiments of the present invention have been described, it should be understood that various changes, adaptations and modifications may be made thereto. It should be understood, therefore, that the invention is not limited to details of the illustrated invention shown in the figures and tables, and that variations in such minor details will be apparent to one skilled in the art.